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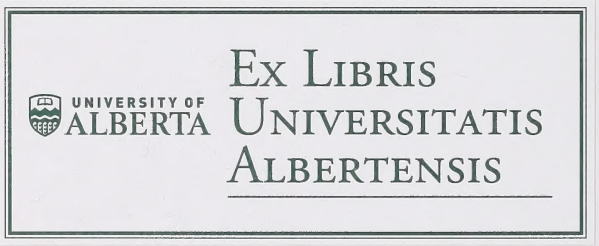
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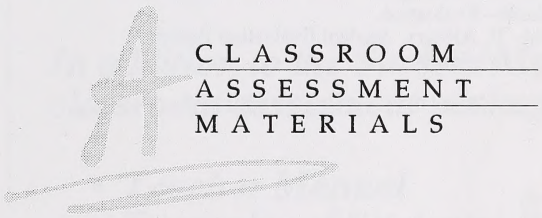
MATHEMATICS 20

STUDENT MATERIALS



Alberta
EDUCATION

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Mathematics 20

This package of Student Materials contains

- *End-of-Course Exam*
- *Performance Assessment*
- *Projects*

In addition to the Student Materials, this classroom assessment package includes

- *Teacher Manual*
- *Examples of Students' Responses*

CLASSROOM ASSESSMENT MATERIALS

Mathematics 20

The End-of-Course Exam

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End-of-Course Exam

Description

Time allotted: 1.5 h. You may take an additional 0.5 h to complete the exam.
This is a **closed-book** exam consisting of **three** parts:

Part A
has 28 selected-response questions

Part B
has 4 numerical-response questions

Part A and ***Part B*** are worth 80% of the exam.

Part C
has 2 written-response questions each worth 10% of the exam.

A formula sheet is included in this booklet.
All graphs on this examination are computer-generated.

Instructions

- Fill in the information required on the answer sheet and the exam booklet as directed by the teacher.
- You are expected to provide your own scientific calculator.
- Carefully read the instructions for each part before proceeding.
- Answers to the selected-response questions and numerical-response questions are to be recorded on the answer sheet provided.
- All your work for the written-response question is to be done in the exam booklet.
- The teacher will collect your answer sheet and exam booklet.
- Do not fold the answer sheet.

Part A: Selected Response
28 Questions

Instructions

- Consider all numbers used in the questions to be **exact real** numbers and not the result of a measurement.
- Read each question carefully and decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

  Example

  This test is for the subject of

  A. biology
  B. physics
  C. chemistry
  D. mathematics

  Answer Sheet

  Ⓐ Ⓑ Ⓒ ●

- **Use an HB pencil only.**
- If you wish to change an answer, erase **all** traces of your first answer.

Do not turn the page to start the exam until told to do so by the teacher.

1. With a base of 3, an equivalent expression for $\left(\sqrt[4]{81}\right)^3$ is

A. 3^{-3}

B. $3^{\frac{3}{2}}$

C. 3^3

D. $3^{\frac{16}{3}}$

2. The expression $3\sqrt{12} + 5\sqrt{8} - \sqrt{18}$ may be written as

A. $11\sqrt{2} + 12\sqrt{3}$
B. $7\sqrt{2} + 6\sqrt{3}$
C. $29\sqrt{2}$
D. $13\sqrt{2}$

3. The expression $\frac{\left(3^{2x+1}\right)\left(9^{x-3}\right)}{27^{x-1}}$ is equal to

A. 3^{x-2}
B. 3^{x-8}
C. 27^{2x-1}
D. 27^{2x-3}

4. The expression $\left(2\sqrt{3}+1\right)^2$ is equal to

A. 7
B. 13
C. $7 + 4\sqrt{3}$
D. $13 + 4\sqrt{3}$

5. Which of the following expressions fails to be defined at $x = 5$?

A. $\frac{x-5}{5}$

B. $\frac{x^2-25}{5x}$

C. $\frac{x^2-25}{(x+5)^2}$

D. $\frac{(x-5)(x+5)}{(x-5)(x+5)}$

6. An equivalent form of $\frac{x^2+4x-32}{4x+32}$, $x \neq -8$ is

A. $x-1$

B. x^2-1

C. $4(x-4)$

D. $\frac{x-4}{4}$

7. The expression $\frac{1}{x+2} - \frac{3}{x-5}$, where $x \neq -2$, $x \neq 5$, is equal to

A. $\frac{2}{3}$

B. $\frac{-6}{x-5}$

C. $\frac{-2x+1}{(x+2)(x-5)}$

D. $\frac{-2x-11}{(x+2)(x-5)}$

8. The solution to the equation $\frac{2}{x}+\frac{6}{x-1}=\frac{4}{x(x-1)}$ is

A. $\frac{3}{4}$

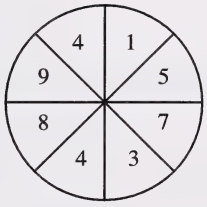
B. $-\frac{1}{2}$

C. $0, 1$

D. 0

Use the following information to answer the next question.

Use the spinner shown below to answer the following question.



9. The probability that on one spin, the result is a number that is less than 5 or is even is

A. 0.500

B. 0.625

C. 0.750

D. 0.875

10. Two strangers enter an elevator on the fifth floor of a building. If the elevator is going down, and the probability that either of them will exit on any of the remaining 4 floors is equal, the probability that both will exit on the second floor is

A. $\frac{1}{4}$

B. $\frac{1}{8}$

C. $\frac{3}{16}$

D. $\frac{1}{16}$

11. Which of the following relations is **not** a function?

A. $y = 10$

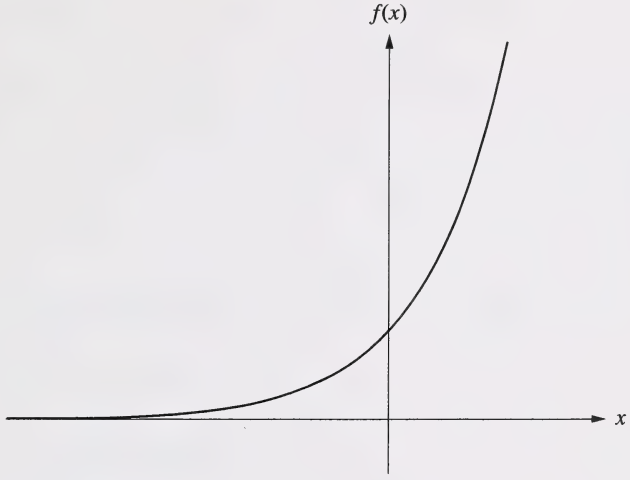
B. $y = x^2 - 3$

C. $\{(1,3),\ (2,5),\ (3,7),\ (7,7)\}$

D. $\{(2,-1),\ (3,1),\ (5,3),\ (5,5)\}$

Use the following information to answer the next question.

A partial graph of $f(x) = 2^x$ is shown below.



12. The largest possible domain and the corresponding range of the function, respectively, are

A. $x > 0$, and $f(x) > 1$

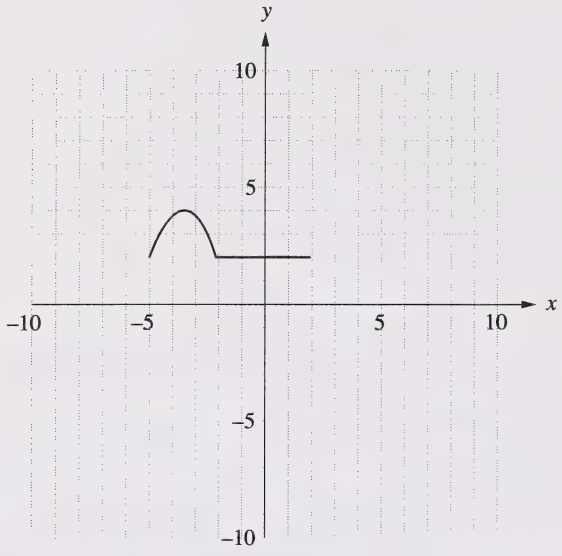
B. $x > 0$, and $f(x) \in \Re$

C. $x \in \Re$, and $f(x) > 0$

D. $x \in \Re$, and $f(x) \in \Re$

Use the following information to answer the next question.

The graph of $y = f(x)$ is shown below.



13. The quadrant that will contain the graph of the transformed function $g(x) = 2f(x - 7) + 9$ is

A. I
B. II
C. III
D. IV

14. The relation which contains an absolute value function is

A. $f(x) = \left(\frac{1}{2}\right)^x$

B. $f(x) = 3x^2 + 2x$

C. $f(x) = -\frac{2}{3}x + |-5|$

D. $f(x) = \left|-\frac{1}{4}x\right| - 7$

15. The values of the function $f(x) = -(x+3)^2 + 16$ are positive when

A. $x < -7,\ x > 1$

B. $-7 < x < 1$

C. $x > -3$

D. $x > 0$

16. $f(x) = a(x+3)^2 - 8,\ a > 0$. Which of the following is the **true** statement about this function?

A. The function has a minimum value of 3.

B. The function has a maximum value of 3.

C. The function has a minimum value of –8.

D. The function has a maximum value of –8.

17. When an arrow is shot into the air, the equation $h(t) = v_0 t - 5t^2 + 5$ gives the approximate height, h, in metres of the arrow after t seconds in the air. If the initial velocity, v_0, is 20 m/s, then the maximum height reached by this arrow, correct to the nearest tenth, is

A. 25 m

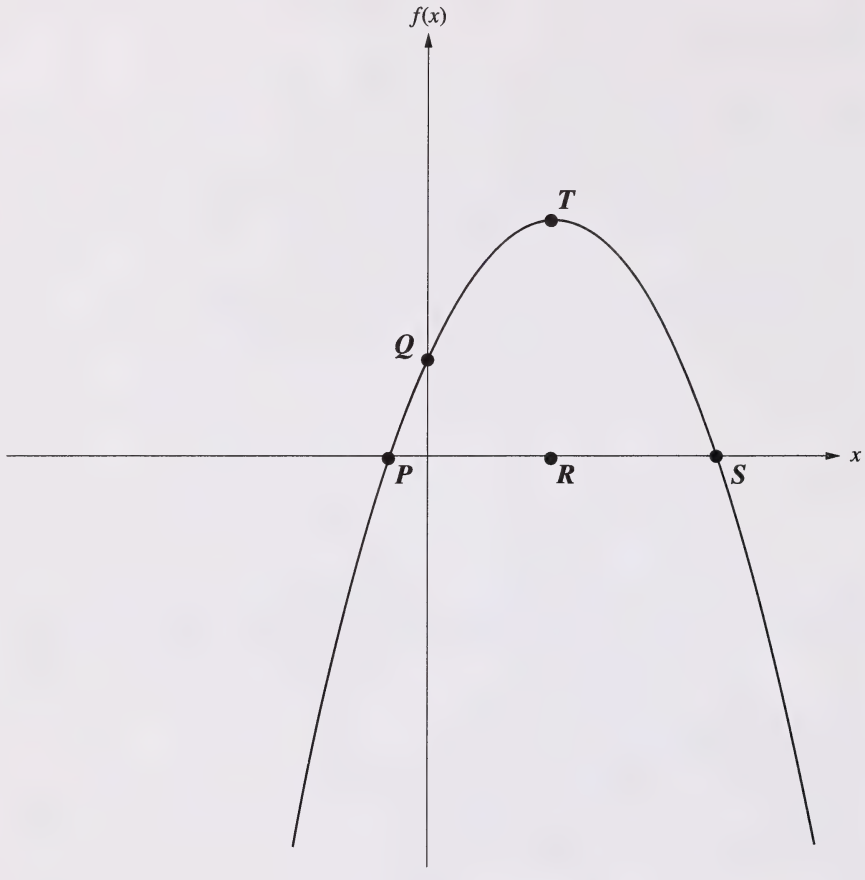
B. 21 m

C. 20 m

D. 19 m

Use the following information to answer the next question.

The graph of $f(x)$ is shown below.



18. The points that imply the roots of the equation $f(x) = 0$ are

A. P and S

B. P and Q

C. P, Q, and S

D. P, R, and S

19. For what values of k does the equation $2x^2 + kx + 5 = 0$ have two equal real roots?

A. $k = \pm 2\sqrt{10}$

B. $k = \pm 4\sqrt{10}$

C. $k > 2\sqrt{10}$

D. $k > 4\sqrt{10}$

20. If the value of the discriminant of a quadratic equation with real number coefficients is greater than zero, then the quadratic equation

A. has 2 equal real roots

B. has 2 distinct real roots

C. has 2 equal non-real roots

D. has 2 distinct non-real roots

21. An express train travels 600 km. A car travelling 50 km/h slower than the train takes 6 hours longer to travel the same distance. If x describes the average speed of the train, then an equation that can be used to determine the value of x is

A. $\frac{600}{x-50} = \frac{600}{x} + 6$

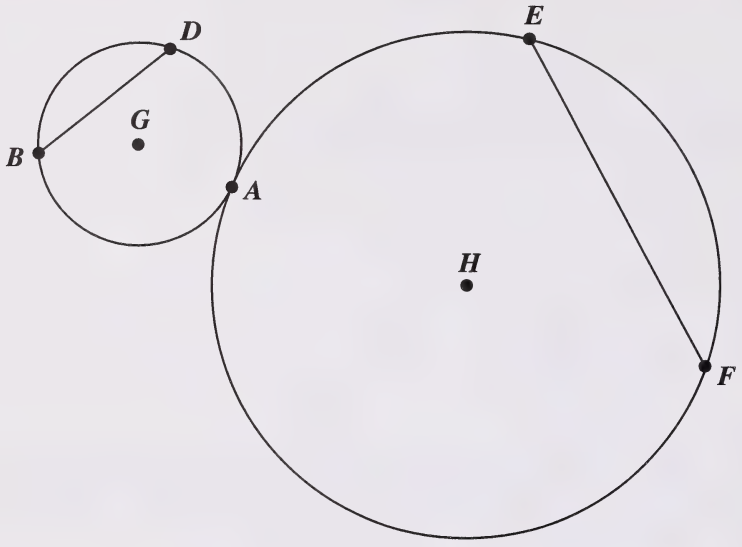
B. $\frac{600}{x-50} = \frac{600}{x} - 6$

C. $\frac{600}{x+50} - \frac{600}{x} = 6$

D. $\frac{600}{x} - \frac{600}{x+50} = 6$

Use the following information to answer the next question.

Two circles are tangent to each other at point A. The smaller circle has a chord $\overline{BD}$ that is 8 cm long, and is 3 cm from its centre, point G. The larger circle has a chord $\overline{EF}$ that is 48 cm long, and is 10 cm from its centre, point H. The diagram below shows this information.

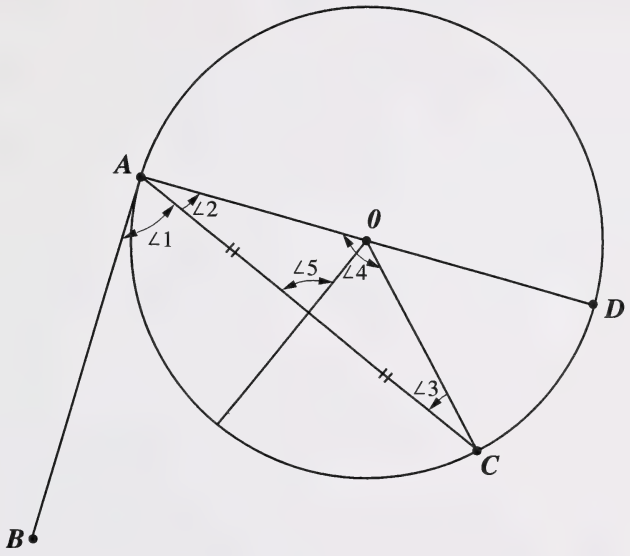


22. Correct to the nearest tenth, the distance between the centres of the circles is

A. 14.4 cm
B. 21.0 cm
C. 29.2 cm
D. 31.0 cm

Use the following information to answer the next question.

The circle with centre O with diameter $\overline{AD}$ is shown below. C lies on the circle and $\overline{AB}$ is a tangent.



23. Which of the following statements about the measures of the labelled angles is always **true**?

A. $\angle 1 + \angle 2 = \angle 5$

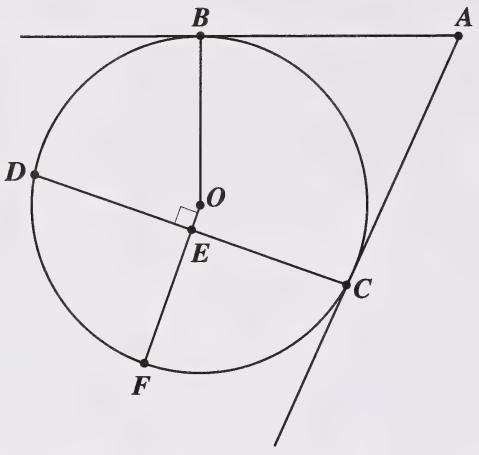
B. $\angle 2 + \angle 3 = \angle 4$

C. $\angle 1 = \angle 2$

D. $\angle 4 = \angle 5$

Use the following information to answer the next question.

A circle with centre O is shown below. The circle has two tangents, $\overline{AB}$ and $\overline{AC}$. Points B, C, D, and F lie on the circle while point E lies on $\overline{CD}$ and $\overline{OF}$. $\overline{OF}$ is perpendicular to $\overline{CD}$.



24. Which of the following statements about this circle is **false**?

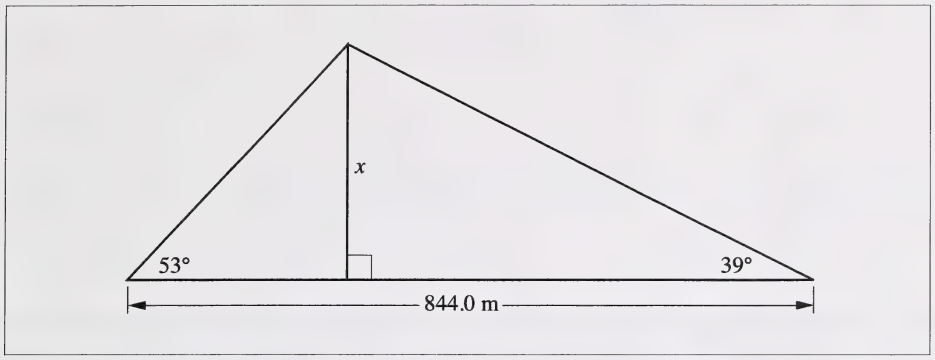
A. $\overline{OB}$ is perpendicular to $\overline{AB}$.

B. $\overline{CD}$ is perpendicular to $\overline{AC}$.

C. The length of $\overline{AB}$ equals the length of $\overline{AC}$.

D. The length of $\overline{DE}$ equals the length of $\overline{EC}$.

Use the following information to answer the next question.



25. Correct to the nearest tenth of a metre, the measure of x is

A. 405.7 m
B. 424.5 m
C. 531.5 m
D. 560.0 m

---

26. Which of the following angles is **not** coterminal with 240°?

A. –120°
B. –480°
C. 420°
D. 960°

27. If θ is an angle in standard position and if the value of $\sin\theta$ is -0.9063, then the terminal arm of θ is in quadrant

A. I or II

B. II or III

C. II or IV

D. III or IV

28. Two airplanes are flying, in opposite directions, in a vertical plane directly away from a terminal. When their distances along the flight path are 2.4 km and 3.6 km from the terminal, the distance between them is 4.1 km. Correct to the nearest tenth of a degree, the angle between the flight paths is

A. 35.6°

B. 48.2°

C. 60.8°

D. 83.7°

You have now completed Part A. Proceed directly to Part B.

Part B: Numerical Response

4 Questions

Instructions

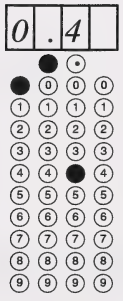
- Consider all numbers used in the questions to be **exact real** numbers and not the result of a measurement.
- Read each question carefully.
- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**
- Use an HB pencil only.
- If you wish to change an answer, erase **all** traces of your first answer.

Sample Questions and Solutions

Correct to the nearest tenth, the fraction $\frac{2}{5}$ is equal to _____ .

$$\frac{2}{5} = 0.4$$

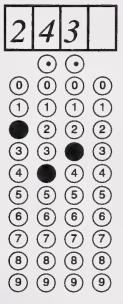
Record 0.4 on the answer sheet →



The numerical value of $3^2 \times 3^3$ is _____.

$$3^2 \times 3^3 = 3^5$$
$$= 243$$

Record 243 on the answer sheet →



Numerical Response

1. If $(2, -5)$ satisfies $f(x) = 2x^3 - kx^2 + 5x + 1$, then the value of k, to the nearest tenth, is _____ .

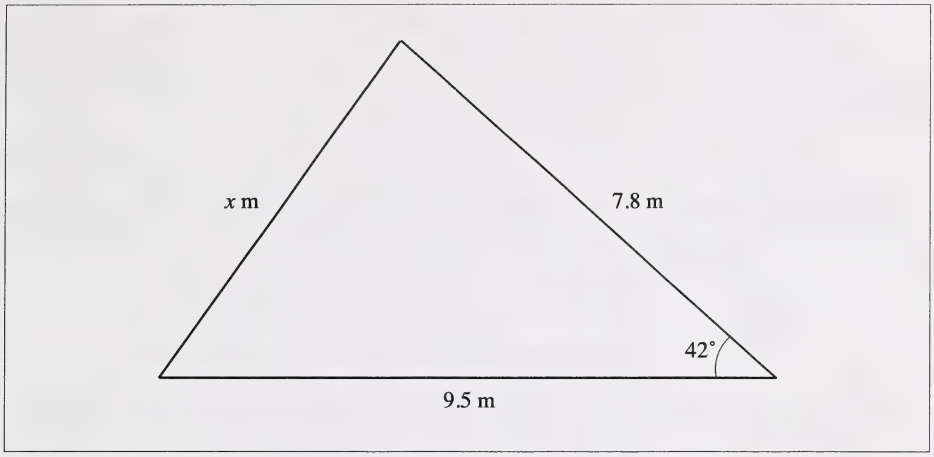
Numerical Response

2. The inverse $g(x)$ of $f(x) = 9x^2$ for $x > 0$ is $g(x) = k\sqrt{x}$, $x > 0$. Correct to the nearest hundredth, the positive value of k is equal to _____ .

Numerical Response

3. If $y = 2x^2 + 4x + 5$ is written in the completed square form $y = a(x - h)^2 + q$, then the value of q, correct to the nearest tenth, is equal to _____ .

Use the following information to answer the next question.



4. Correct to the nearest tenth of a metre, the measure of the third side, x, of the triangle is _____ m.

You have now completed Part B. Proceed directly to Part C.

Part C: Written Response
2 Questions

Instructions

- Consider all numbers used in the question to be **exact real** numbers and not the result of a measurement.
- Read the question carefully.
- Write your answers in the exam booklet as neatly as possible.
- For full marks, your answers **must show all** pertinent explanations, calculations, and formulas.
- Your answers **should be** presented in a well-organized and appropriate manner.
- The written-response questions will be scored according to the following:
  - communication of a clear understanding of the problem
  - selection of appropriate strategies that demonstrate mathematical knowledge and problem-solving techniques to find solutions

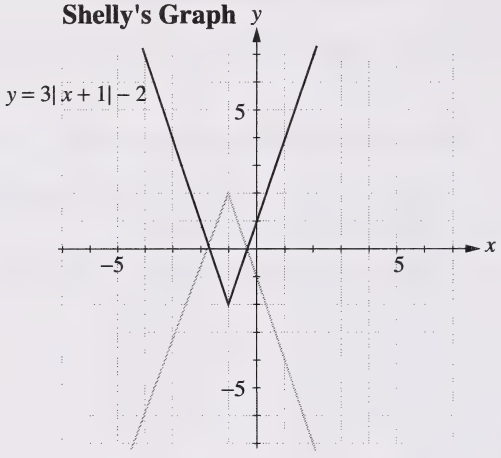
Start Part C immediately.

Written Response – 4 marks

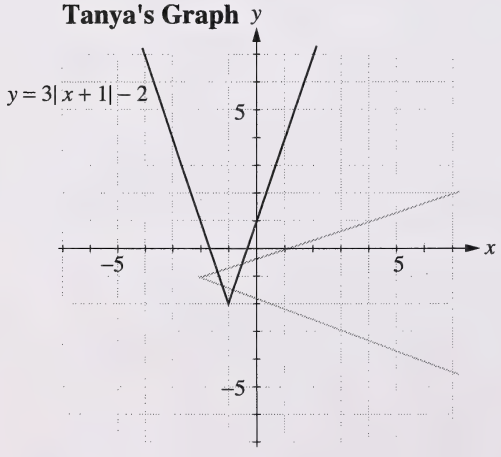
1. Shelly and Tanya are investigating the absolute value function. Both Shelly and Tanya correctly graph $y = 3|x + 1| - 2$, and then they each graph what they believe to be the inverse of this function.

Either Shelly or Tanya constructed a correct graph. Shelly concludes that the inverse of this function is a function, whereas Tanya concludes that the inverse of this function cannot be described by a single function. Identify who is correct, and explain how you reached your conclusion.

Shelly's Graph



Tanya's Graph



(Question 1 continued on the next page.)

(Question 2 is on the next page.)

Written Response – 4 marks

2. Most linear measurements in Canada are represented by a metric unit such as the metre. However, Canadian football continues to measure in yards. While watching a football game, Justin views an opening kick. The path that the football travels is parabolic, reaching a maximum height of 12 yards. When the football lands, it has travelled 60 yards down the field.

- Sketch the path that the football travels on a coordinate system. Assume that the origin represents the place where the football is kicked. Points plotted on the coordinate system should be of the form

  (distance football travels downfield, height of football).

- Identify the position of the horizontal intercepts and the vertex, and label the graph.

- Determine the equation of the relation between the height of the ball and its distance down the field from the kickoff point.

(Question 2 continued on the next page.)

You have now completed the exam.
If you have time, you may wish to check your answers.

Formula Sheet

The following information may be useful in writing this exam.

- The roots of the quadratic equation $ax^2 + bx + c = 0$ are

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

- The distance between two points (x_1, y_1) and (x_2, y_2) is

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

- The slope of a line segment with endpoints (x_1, y_1) and (x_2, y_2) is

$$m = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

- The midpoint of a line segment with endpoints (x_1, y_1) and (x_2, y_2) is

$$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$

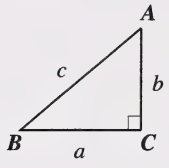
Trigonometry

- In a right triangle labelled ABC, where $\angle C$ is the right angle, then

$$\cos A = \frac{b}{c}$$

$$\sin A = \frac{a}{c}$$

$$\tan A = \frac{a}{b}$$



- $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$
- $c^2 = a^2 + b^2 - 2ab \cos C$

Probability

- The probability of two independent events, A and B, occurring is

$$P(A \text{ and } B) = P(A) \times P(B)$$

- The probability of two dependent events, A and B, occurring is

$$P(A \text{ and } B) = P(A) \times P(B/A)$$

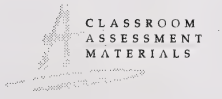
- The probability of one or the other of two events, A and B, occurring is

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

CLASSROOM ASSESSMENT MATERIALS

Mathematics 20

Performance Assessment



Student Task

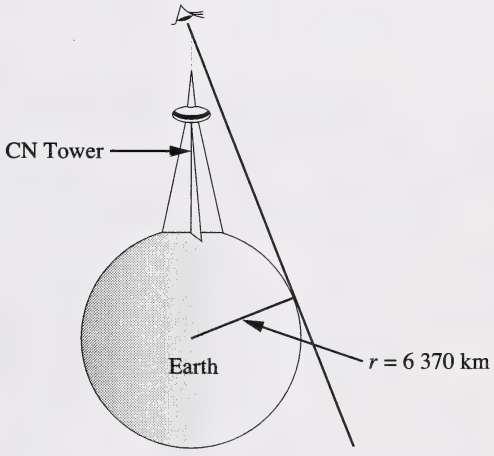
Name _____

According to the song, *"on a clear day you can see forever"*; however, on a curved planet this is **not** true!

The following tasks are concerned with the range of vision of an observer on a curved planet.

In order to assist you in modelling parts of the following tasks, obtain from your teacher:
- 1 ice cream pail lid
- a needle
- a piece of thread or string

Suppose that from the top of the CN Tower, which is 400 m high, your line of vision is as shown below. Earth has a radius of 6 370 km.



- Calculate the farthest distance that can be seen from the top of the CN Tower. A model simulating this situation may assist you with your solution.

- Suppose the farthest distance a person standing on level ground can see is 4.6 km. How many metres above the ground is the person's line of vision?

- Derive a formula expressing the maximum distance seen (d), in terms of the radius of a planet (R), and the height of the observer (h).

Show your solution
in the space provided
on the next page.

Scoring Criteria for Performance Assessment	
5 marks	The student • demonstrates an understanding of the problem. • uses appropriate mathematical knowledge and problem-solving techniques to find the solution • justifies the solution
4 marks	The student • demonstrates an understanding of the problem • uses appropriate mathematical knowledge and problem-solving techniques to find a solution, but the solution contains a minor flaw • shows some justification for results
3 marks	The student • demonstrates some understanding of the problem • uses appropriate mathematical knowledge and problem-solving techniques to find *partial* solutions • communicates little understanding of the complexities of the problem • formulates some aspects of the problem mathematically
2 marks	The student • explores the initial stages of the problem • applies some relevant mathematical knowledge and problem-solving techniques to find *partial* solutions
1 mark	The student • applies some relevant mathematical knowledge to the problem
0 mark	The student • is off topic, or leaves the paper blank

Mathematics 20

Projects

Project A — Theme: Relations and Functions

Student Task

Your project must be based upon the theme *Relations and Functions*. However, you must discuss your choice of topic and how it relates to the theme with your teacher. The examples listed below are **possible starting points.** It is possible to combine related ideas, but keep in mind that an investigative project is intended to include **depth** as well as **breadth** of research. Choose one of the examples below or a related topic of your own, for your project.

Using a computer program or a graphing calculator

1. The order in which operations are performed in mathematics can be important. Investigate the effects of varying the order of introducing changes in the values of the parameters (one at a time), in the graphs of $y = cf(x - a) + b$.
2. During your Mathematics 20 course, you have studied functions such as linear, quadratic, reciprocal, cubic, exponential, and absolute value. Investigate a minimum of two other functions to determine if the properties of transformations are consistent with what you have learned. As an extension, you may wish to investigate transformations applied to relations such as circles.
3. Investigate how parabolas are used in everyday applications such as suspension bridges (e.g., the Golden Gate Bridge), satellite dishes, arches, car headlights, etc.
4. Many phenomena in physics and chemistry are described by equations involving variation (e.g., Charles' Law and Boyle's Law in chemistry, etc.). Investigate a minimum of three such equations, identifying which are direct, inverse, or partial variations, the domain and range, and the dependent and independent variables. Using a computer graphing package, on the same set of axes produce graphs from which a variety of information can be read. For example, on one set of axes, show the relationship of temperature and volume for Charles' Law, producing several graphs that each show this relationship for a different fixed value of pressure.
5. Using a minimum of three types of functions studied in Mathematics 20 (e.g., parabolas, exponential, absolute value), create a computer program that displays a kaleidoscope of colours. An alternative would be to create a static two-dimensional or three-dimensional design.

In your investigative project:

- include a statement with supporting arguments, as to whether the relations you have worked with are functions
- determine all domains and ranges
- describe, explain, and illustrate, where appropriate, any transformations; i.e., reflections, vertical stretches, translations
- determine the equations of the functions used
- identify x-intercepts of graphs, zeros of functions, and roots of equations, as appropriate
- acknowledge which areas of mathematics you use: arithmetic, geometry, trigonometry, and/or algebra
- include the type of computer software program or graphing calculator you used and your own analysis

Project B — Math History: A Neglected Domain

Student Task

It has often been said that mathematics is a subject that loses a great deal by not rooting it in its history. The subject is taught and learned with little or no reference to the people who contributed major ideas and who were responsible for the advancement of mathematical thought.

Your project must be based on the theme ***Math history: a neglected domain***. Select one of the topics listed below, or, if your prefer, investigate any topic related to this theme. You must however, discuss your choice of topic with your teacher.

Projects should reflect **depth** as well as **breadth** of research. It is expected that your report will include a thorough but concise biography of the mathematicians named in each question (this may be presented in the form of a poster), a precise discussion of the individual's contribution to the advancement of mathematics, and references to where these ideas are reflected in our mathematics curriculum. Choose one of the examples below or a related topic of your own, for your project.

1. **John Napier** is credited with the invention of logarithms and a tool for calculation called Napier's Rods or Napier's Bones. Provide a complete and clear explanation of both of these inventions.

2. **Blaise Pascal** is recognized for the introduction and use of Pascal's triangle. In fact, Pascal did not develop Pascal's triangle. Find the origin of this famous triangle, and provide a number of examples of its use.

3. **Sonya Kovalevski, Sophie Germain**, and **Emmy Noether** are three women mathematicians who had the courage and determination to enter a male-dominated field, and contribute to the development of mathematics. Discuss their contributions and provide explanations of the social and cultural obstacles that may have prevented women from becoming mathematicians. Describe the environment that a woman would face today if she elected to specialize in mathematics.

4. **George Pólya**, a twentieth-century mathematician and author of *How to Solve It*, is considered a pioneer in the field of problem solving. Discuss his approach to problem solving and explain if, in your view, his methods are reflected in the way mathematics is taught in our schools. Select one of his famous problems and provide a clear and logical solution.

5. **René Descartes** is the inventor of analytical geometry. Give a description of this branch of mathematics and compare it to Euclidean geometry. Explain the importance of analytical geometry in the development of mathematics. Give a description of a circle using Euclidean geometry, Cartesian geometry and algebra.

6. **Sir Isaac Newton** and **Gottfried Wilhelm Leibniz** are considered rivals in mathematics. Provide examples of this rivalry and focus on what became known as the Newton-Leibniz controversy.

Project Report Format

Your report should include most, if not all, of the elements on this page.

1. Title page

Include:

- The exact title of the project
- The Mathematics course number
- The date of submission
- The student and teacher names

2. Main Text

Include:

- A table of contents
- A clear statement of the topic
- An accurate and detailed accounting of the processes used in the project, including any unique equipment, scientific procedure details, mathematical calculations, data, and graphs. If the project was conducted by a group, the roles of individual students should be documented.
- No more than 1500 words, and be limited to 10 pages

3. Summary Section

Include:

- Project conclusions which summarize or bring together the investigated ideas
- A statement regarding the limitations of the project, and possible further investigations that could be done as a result of this project.
- A brief summary of the mathematical knowledge encountered during the investigation and a statement of the areas of study from which it was drawn; e.g., statistics, trigonometry, etc. An indication, if appropriate, should also be given of how computers or calculators were used.

4. Acknowledgements

In this section, acknowledge the assistance provided by librarians, student partners, specialist information sources, family, teachers, and other sources.

5. References

Those references actually consulted and found to be useful should be included and cited within the main text where used; e.g., an equation, a definition, data, a commercial computer program.

6. Appendices (if necessary)

These should be numbered consecutively. Each should bear a title and be specifically referred to in the text. Include here necessary lengthy calculations, original computer programs (listing and output), raw data, or other essential resources. For repetitive calculations, the first one should be detailed in the main text and the rest included in the appendices.

Scoring Criteria for Assessing Student Project

Scoring Categories	Not Shown ( ) marks	Low ( ) marks	Medium ( ) marks	High ( ) marks	Comments
Defining the Project (10%)	(0)	(1)	(2)	(3)	
Conducting the Project (20%)	(0)	(2)	(4)	(6)	
Analysis (20%)	(0)	(2)	(4)	(6)	
Mathematical Content (30%)	(0)	(3)	(6)	(9)	
Communication (20%)	(0)	(2)	(4)	(6)	

Total marks: 30 _____%

Using the Scoring Criteria

A student's project will be rated on several categories; and the scores summed from each category to obtain a total mark for the entire project. This type of scoring, referred to as *anaholistic*, provides more information about a task and furnishes information from different perspectives, pinpointing strengths and weaknesses. The *Scoring Criteria* has three categories that relate specifically to parts of the project. These are *Defining the Project, Conducting the Project,* and *Analysis*. The last two categories, *Mathematical Content* and *Communication*, are intended to be used as overall assessment categories for the entire project.

In the body of the table, possible marks for each category are indicated in brackets. For example, the total possible marks for the category *Defining the Project* is 3, whereas the total possible marks for *Mathematical Content* is 9. Each category has a continuum of marks. For example, a student may receive a mark anywhere from 0 to 9 on the *Mathematical Content*. The marks allotted in each of the five sections of categories are summed for a possible total of 30.

Details for using the *Scoring Criteria* are on the next page.

Scoring Categories for Mathematics 20: Projects A and B	*Ratings*
Defining the Project : • identifying information required • asking useful questions • acknowledging difficulties and limitations • suggesting extensions • statement of project topic • statement of purpose of project	3 – thoroughly evident 2 – substantially evident 1 – minimally evident 0 – not shown
Conducting the Project : • collecting appropriate factual information • consulting appropriate resources (peers, teachers, references) • organizational skills	6 – exemplary 4 – effective 2 – marginal 0 – not evident
Analysis : • analyzing information • interpreting and critically evaluating the mathematics • drawing logical conclusions • evaluation of conclusions	6 – thoroughly developed 4 – partially developed 2 – minimally developed 0 – not developed
Overall Categories	***Ratings***
Mathematical Content : • connection of the mathematics researched to our curriculum • use of mathematical language and symbols • mathematical formulation or interpretation of problem • interpretation and evaluation of mathematics used	9 – proficient 6 – adequate 3 – marginal 0 – unsatisfactory
Communication : • coherent presentation • information clearly presented • references cited • acknowledgement of assistance • appendices	6 – clear, well-organized, complete 4 – mostly clear and well-organized 2 – some clear parts 0 – unclear and disorganized

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